DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Memorandum

Date · NOV 12 1996

From Director, Office of Device Evaluation (HFZ-400)
Center for Devices and Radiological Health (CDRH)

Subject Premarket Approval of Intermedics Inc.
ThinLine™ Models 430-10 and 432-04 Endocardial Pacing Leads - ACTION

To The Director, CDRH
ORA _____

ISSUE. Publication of a notice announcing approval of the subject PMA.

FACTS. Tab A contains a FEDERAL REGISTER notice announcing:

(1) a premarket approval order for the above referenced medical device (Tab B); and

(2) the availability of a summary of safety and effectiveness data for the device (Tab C).

RECOMMENDATION. I recommend that the notice be signed and published.

Susan Alpert, Ph.D., M.D.

Attachments
Tab A - Notice
Tab B - Order
Tab C - S & E Summary

DECISION

Approved _____ Disapproved _____ Date _____

Prepared by Lynette Gabriel, CDRH, HFZ-450, 443-8243

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Food And Drug Administration

[DOCKET NO. _____]

INTERMEDICS INC.; PREMARKET APPROVAL OF THINLINE™ MODELS 430-10 AND 432-04 ENDOCARDIAL PACING LEADS

AGENCY: Food and Drug Administration, HHS.

ACTION: Notice.

SUMMARY: The Food and Drug Administration (FDA) is announcing its approval of the application by Intermedics Inc., Angleton, TX, for premarket approval, under the Federal Food, Drug, and Cosmetic Act (the act), of the ThinLine™ Models 430-10 and 432-04 Endocardial Pacing Leads. FDA's Center for Devices and Radiological Health (CDRH) notified the applicant, by letter of November 12, 1996, of the approval of the application.

DATES: Petitions for administrative review by (insert date 30 days after date of publication in the FEDERAL REGISTER).

ADDRESSES: Written requests for copies of the summary of safety and effectiveness data and petitions for administrative review, to the Dockets Management Branch (HFA-305), Food and Drug Administration, 12420 Parklawn Dr., rm. 1-23, Rockville, MD 20857.

FOR FURTHER INFORMATION CONTACT:

Lynette Gabriel,

Center for Devices and Radiological Health (HFZ-450),

Food and Drug Administration,

9200 Corporate Blvd.,

Rockville, MD 20850,

301-443-8243.

SUPPLEMENTARY INFORMATION: On January 29, 1996, Intermedics Inc., Angleton, TX 77515, submitted to CDRH an application for premarket approval of ThinLine™ Models 430-10 and 432-04 Endocardial Pacing Leads. These devices are permanent pacing leads and are indicated for chronic pacing and sensing of the atrium or ventricle when used with a compatible pulse generator.

In accordance with the provisions of section 515(c)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory System Devices Panel of the Medical Devices Advisory Committee, an FDA advisory committee, for review and recommendation because the information in the PMA substantially duplicates information previously reviewed by this panel.

On November 12, 1996, CDRH approved the application by a letter to the applicant from the Director of the Office of Device Evaluation, CDRH.

A summary of the safety and effectiveness data on which CDRH based its approval is on file in the Dockets Management Branch (address above) and is available from that office upon written request. Requests should be identified with the name of the device and the docket number found in brackets in the heading of this document. Requests should be identified with the name of the device and the docket number found in brackets in the heading of this document.

Opportunity for Administrative Review

Section 515(d)(3) of the act,(21 U.S.C. 360e(d)(3)) authorizes any interested person to petition, under section 515(g) of the act, for administrative review of CDRH's decision

to approve this application. A petitioner may request either a formal hearing under 21 CFR part 12 of FDA's administrative practices and procedures regulations or a review of the application and CDRH's action by an independent advisory committee of experts. A petition is to be in the form of a petition for reconsideration under 21 CFR 10.33(b). A petitioner shall identify the form of review requested (hearing or independent advisory committee) and shall submit with the petition supporting data and information showing that there is a genuine and substantial issue of material fact for resolution through administrative review. After reviewing the petition, FDA will decide whether to grant or deny the petition and will publish a notice of its decision in the FEDERAL REGISTER. If FDA grants the petition, the notice will state the issue to be reviewed, the form of the review to be used, the persons who may participate in the review, the time and place where the review will occur, and other details.

Petitioners may, at any time on or before (insert date 30 days after date of publication in the FEDERAL REGISTER), file with the Dockets Management Branch (address above) two copies of each petition and supporting data and information, identified with the name of the device and the docket number found in brackets in the heading of this document. Received petitions may be seen in the office above between 9 a.m. and 4 p.m., Monday through Friday.

This notice is issued under the Federal Food, Drug, and Cosmetic Act (secs. 515(d), 520(h), (21 U.S.C. 360e(d), 360j(h))) and under authority delegated to the Commissioner of Food and Drugs (21 CFR 5.10) and redelegated to the Director, Center for Devices and Radiological Health (21 CFR 5.53).

Dated:_____.

_____

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Rockville MD 20857

NOV 12 1996

M. Alaine Medio, RAC
Regulatory Affairs Specialist
Intermedics Inc.
4000 Technology Drive
Angleton, Texas 77515

Re: P960004
ThinLine™ Models 430-10 and 432-04 Endocardial Pacing Leads
Filed: January 29, 1996
Amended: August 19, 1996 and September 30, 1996

Dear Ms. Medio:

The Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) has completed its review of your premarket approval application (PMA) for the ThinLine™ Models 430-10 and 432-04 Endocardial Pacing Leads. These devices are indicated for chronic pacing and sensing of the atrium or ventricle when used with a compatible pulse generator. We are pleased to inform you that the PMA is approved subject to the conditions described below and in the "Conditions of Approval" (enclosed). You may begin commercial distribution of the device upon receipt of this letter.

The sale, distribution, and use of this device are restricted to prescription use in accordance with 21 CFR 801.109 within the meaning of section 520(e) of the Federal Food, Drug, and Cosmetic Act (the act) under the authority of section 515(d)(1)(B)(ii) of the act. FDA has also determined that to ensure the safe and effective use of the device that the device is further restricted within the meaning of section 520(e) under the authority of section 515(d)(1)(B)(ii) insofar as the sale, distribution, and use must not violate sections 502(q) and (r) of the act.

CDRH will publish a notice of its decision to approve your PMA in the FEDERAL REGISTER. The notice will state that a summary of the safety and effectiveness data upon which the approval is based is available to the public upon request. Within 30 days of publication of the notice of approval in the FEDERAL REGISTER, any interested person may seek review of this decision by requesting an opportunity for administrative review, either through a hearing or review by an independent advisory committee, under section 515(g) the act.

Failure to comply with the conditions of approval invalidates this approval order. Commercial distribution of a device that is not in compliance with these conditions is a violation of the act.

You are reminded that, as soon as possible and before commercial distribution of your device, you must submit an amendment to this PMA submission with copies of all approved labeling in final printed form.

All required documents should be submitted in triplicate, unless otherwise specified, to the address below and should reference the above PMA number to facilitate processing.

PMA Document Mail Center (HFZ-401)
Center for Devices and Radiological Health
Food and Drug Administration
9200 Corporate Blvd.
Rockville, Maryland 20850

In addition under section 522(a) of the act manufacturers of certain types of devices identified by the act or designated by FDA are required to conduct postmarket surveillance studies. FDA has identified under section 522(a)(1)(A) the above noted device as requiring postmarket surveillance.

Upon approval and within thirty (30) days of first introduction or delivery for introduction of this device into interstate commerce you will be required to submit to FDA certification of the date of introduction into interstate commerce, a detailed protocol which describes the postmarket surveillance study, and a detailed profile of the study's principal investigator that clearly establishes the qualifications and experience of the individual to conduct the proposed study. For your information, general guidance on preparing a protocol for a postmarket surveillance study is enclosed.

At that time you should submit five (5) copies to:

Postmarket Studies Document Center
1350 Piccard Drive (HFZ-544)
Rockville, Maryland 20850

Within sixty (60) days of receipt of your protocol, FDA will either approve or disapprove it and notify you of the Agency's action in writing. Do not undertake a postmarket surveillance study without an FDA approved protocol.

Failure to certify accurately the date of initial introduction of your device into interstate commerce, to submit timely an acceptable protocol, or to undertake and complete an FDA approved postmarket surveillance study consistent with the protocol, will be considered violations of section 522. In accordance with the Medical Device Amendments of 1992, failure of a manufacturer to meet its obligations under section 522 is a prohibited act under section 301(q)(1)(C) of the act(21 U.S.C. 331(q)(1)(C)). Further, under section 502(t)(3) of the act (21 U.S.C. 352(t)(3), a device is misbranded if there is a failure or refusal to comply with any requirement under section 522 of the act. Violations of sections 301 or 502 may lead to regulatory actions including seizure of your product, injunction, prosecution, or civil money penalties or other FDA enforcement actions including (but not limited to) withdrawal of your PMA.

If you have any questions concerning postmarket surveillance study requirements, contact the Postmarket Surveillance Studies Branch, at (301) 594-0639.

Under section 519(e) of the act (as amended by the Safe Medical Devices Act in 1990), manufacturers of certain devices must track their products to the final user or patient so that devices can be located quickly if serious problems are occurring with the products. The tracking requirements apply to (1) permanent implants the failure of which would be reasonably likely to have serious adverse health consequences; (2) life sustaining or life supporting devices that are used outside of device user facilities the failure of which would be reasonably likely to have serious adverse health consequences; and (3) other devices that FDA has designated as requiring tracking. Under section 519(e), FDA believes that your device is a device that is subject to tracking because it is a permanent implant whose failure would be reasonably likely to have serious adverse consequences.

FDA's tracking regulations, published in the FEDERAL REGISTER on August 16, 1993, appear at 21 CFR Part 821. These regulations set out what you must do to track a device. In addition, the regulations list example permanent implant and life sustaining or life supporting devices that FDA believes must be tracked at 21 CFR § 821.20(b) and the devices that FDA has designated for tracking at 21 CFR § 821.20(c). FDA's rationale for identifying these devices is set out in the FEDERAL REGISTER (57 FR 10705-10709 (March 27, 1991), 57 FR 22973-22975 (May 29, 1992), and 58 FR 43451-43455 (August 16, 1993)).

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If you have questions concerning this approval order, please contact Lynette Gabriel at (301) 443-8243.

Sincerely yours,

Susan Alpert

Susan Alpert, Ph.D., M.D.
Director
Office of Device Evaluation
Center for Devices and
Radiological Health

Enclosure

Issued 5-2-95

CONDITIONS OF APPROVAL
FOR CARDIAC PACEMAKERS AND PROGRAMMERS

APPROVED LABELING. As soon as possible, and before commercial distribution of your device, submit three copies of an amendment to this PMA submission with copies of all approved labeling in final printed form to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration (FDA), 9200 Corporate Boulevard, Rockville, Maryland 20850.

ADVERTISEMENT. No advertisement or other descriptive printed material issued by the applicant or private label distributor with respect to this device shall recommend or imply that the device may be used for any use that is not included in the FDA approved labeling for the device. If the FDA approval order has restricted the sale, distribution and use of the device to prescription use in accordance with 21 CFR 801.109 and specified that this restriction is being imposed in accordance with the provisions of section 520(e) of the act under the authority of section 515(d)(1)(B)(ii) of the act, all advertisements and other descriptive printed material issued by the applicant or distributor with respect to the device shall include a brief statement of the intended uses of the device and relevant warnings, precautions, side effects and contraindications.

PREMARKET APPROVAL APPLICATION (PMA) SUPPLEMENT. Before making any change affecting the safety or effectiveness of the device, submit a PMA supplement for review and approval by FDA unless the change is of a type for which a "Special PMA Supplement-Changes Being Effected" is permitted under 21 CFR 814.39(d) or an alternate submission is permitted in accordance with 21 CFR 814.39(e). A PMA supplement or alternate submission shall comply with applicable requirements under 21 CFR 814.39 of the final rule for Premarket Approval of Medical Devices.

All situations which require a PMA supplement cannot be briefly summarized, please consult the PMA regulation for further guidance. The guidance provided below is only for several key instances.

A PMA supplement must be submitted when unanticipated adverse effects, increases in the incidence of anticipated adverse effects, or device failures necessitate a labeling, manufacturing, or device modification.

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A PMA supplement must be submitted if the device is to be modified and the modified device should be subjected to animal or laboratory or clinical testing designed to determine if the modified device remains safe and effective.

A "Special PMA Supplement - Changes Being Effected" is limited to the labeling, quality control and manufacturing process changes specified under 21 CFR 814.39(d)(2). It allows for the **addition** of, but **not the replacement** of previously approved, quality control specifications and test methods. These changes may be implemented before FDA approval upon acknowledgment by FDA that the submission is being processed as a "Special PMA Supplement - Changes Being Effected." This acknowledgment is in addition to that issued by the PMA Document Mail Center for all PMA supplements submitted. **This procedure is not applicable to changes in device design, composition, specifications, circuitry, software or energy source.**

Alternate submissions permitted under 21 CFR 814.39(e) apply to changes that otherwise require approval of a PMA supplement before implementation of the change and include the use of a 30-day PMA supplement or annual postapproval report. FDA must have previously indicated in an advisory opinion to the affected industry or in correspondence with the applicant that the alternate submission is permitted for the change. Before such can occur, FDA and the PMA applicant(s) involved must agree upon any needed testing protocol, test results, reporting format, information to be reported, and the alternate submission to be used.

POSTAPPROVAL REPORTS. Continued approval of this PMA is contingent upon the submission of postapproval reports required under 21 CFR 814.84 at intervals of 1 year from the date of approval of the original PMA. Postapproval reports for supplements approved under the original PMA, if applicable, are to be included in the next and subsequent annual reports for the original PMA unless specified otherwise in the approval order for the PMA supplement. Two copies identified as "Annual Report" and bearing the applicable PMA reference number are to be submitted to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Boulevard, Rockville, Maryland 20850. The postapproval report shall indicate the beginning and ending date of the period covered by the report and shall include the following information required by 21 CFR 814.84:

(1) Identification of changes described in 21 CFR 814.39(a) and changes required to be reported to FDA under 21 CFR 814.39(b).

(2) Bibliography and summary of the following information not previously submitted as part of the PMA and that is known to or reasonably should be known to the applicant:

(a) unpublished reports of data from any clinical investigations or nonclinical laboratory studies involving the device or related devices ("related" devices include devices which are the same or substantially similar to the applicant's device); and

(b) reports in the scientific literature concerning the device.

If, after reviewing the bibliography and summary, FDA concludes that agency review of one or more of the above reports is required, the applicant shall submit two copies of each identified report when so notified by FDA.

In addition to the above and in order to provide continued reasonable assurance of the safety and effectiveness of the device for its intended use, the annual postapproval reports shall include, separately for each model number (if applicable), the following information known by or reported to the applicant:

(1) The number of pacemakers domestically implanted and the number of reported explants and deaths.

(2) A breakdown of the reported deaths into pacemaker related and non-pacemaker related.

(3) A breakdown of the reported explants into the numbers reported at end of battery life, having complications unresolvable by programming and for other reasons with safety and effectiveness issues which can be derived from the reports stated.

(4) The number of pacemakers returned to the applicant for cause from domestic sources with a breakdown into the numbers currently in analysis, operating properly, at normal battery depletion and failed, with the failure mechanisms described.

(5) A cumulative survival table for the pacemakers.

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(6) The number of programmers and modules shipped and the number of returns with a breakdown into the numbers currently in analysis, operating properly and failed, with the failure mechanisms described.

ADVERSE REACTION AND DEVICE DEFECT REPORTING. As provided by 21 CFR 814.82(a)(9), FDA has determined that in order to provide continued reasonable assurance of the safety and effectiveness of the device, the applicant shall submit 3 copies of a written report identified, as applicable, as an "Adverse Reaction Report" or "Device Defect Report" to the PMA Document Mail Center (HFZ-401), Center for Devices and Radiological Health, Food and Drug Administration, 9200 Corporate Boulevard, Rockville, Maryland 20850 within 10 days after the applicant receives or has knowledge of information concerning:

(1) A mixup of the device or its labeling with another article.

(2) Any adverse reaction, side effect, injury, toxicity, or sensitivity reaction that is attributable to the device and

(a) has not been addressed by the device's labeling or

(b) has been addressed by the device's labeling, but is occurring with unexpected severity or frequency.

(3) Any significant chemical, physical or other change or deterioration in the device or any failure of the device to meet the specifications established in the approved PMA that could not cause or contribute to death or serious injury but are not correctable by adjustments or other maintenance procedures described in the approved labeling. The report shall include a discussion of the applicant's assessment of the change, deterioration or failure and any proposed or implemented corrective action by the applicant. When such events are correctable by adjustments or other maintenance procedures described in the approved labeling, all such events known to the applicant shall be included in the Annual Report described under "Postapproval Reports" above unless specified otherwise in the conditions of approval to this PMA. This postapproval report shall appropriately categorize these events and include the number of reported and otherwise known instances of each category during the reporting period. Additional information regarding the events discussed above shall be submitted by the

applicant when determined by FDA to be necessary to provide continued reasonable assurance of the safety and effectiveness of the device for its intended use.

REPORTING UNDER THE MEDICAL DEVICE REPORTING (MDR) REGULATION. The Medical Device Reporting (MDR) Regulation became effective on December 13, 1984, and requires that all manufacturers and importers of medical devices, including in vitro diagnostic devices, report to FDA whenever they receive or otherwise became aware of information that reasonably suggests that one if its marketed devices

(1) may have caused or contributed to a death or serious injury or

(2) has malfunctioned and that the device or any other device marketed by the manufacturer or imported would be likely to cause or contribute to a death or serious injury if the malfunction were to recur.

The same events subject to reporting under the MDR Regulation may also be subject to the above "Adverse Reaction and Device Defect Reporting" requirements in the "Conditions of Approval" for this PMA. FDA has determined that such duplicative reporting is unnecessary. Whenever an event involving a device is subject to reporting under both the MDR Regulation and the "Conditions of Approval" for this PMA, you shall submit the appropriate reports required by the MDR Regulation and identified with the PMA reference number to the following office:

Division of Surveillance Systems (HFZ-531)
Center for Devices and Radiological Health
Food and Drug Administration
1350 Piccard Drive, Room 340
Rockville, Maryland 20850
Telephone (301) 594-2735

Events included in periodic reports to the PMA that have also been reported under the MDR Regulation must be so identified in the periodic report to the PMA to prevent duplicative entry into FDA information systems.

Summary of Safety and Effectiveness Data

Intermedics® ThinLine™ Models 430-10 and 432-04 Implantable Pacing Leads

Table of Contents

I. GENERAL INFORMATION:

PMA Number: P960004

Device Generic Name: Cardiovascular Permanent Pacemaker Electrode

Device Trade Name: ThinLine™ Model 430-10 and 432-04 Endocardial Pacing Leads

Applicant's Name / Address: Intermedics Inc.
4000 Technology Drive
Angleton, Texas 77515

Approved: November 12, 1996

II. DEVICE DESCRIPTION

The ThinLine™ models 430-10 and 432-04 atrial and ventricular bipolar, passive-fixation, endocardial pacing leads are intended for permanent atrial and ventricular placement. Each lead is composed of two individually ETFE-coated conductor wires co-radially wound together to form a single conductor coil. The leads include polyurethane outer insulation and iridium oxide-coated (IROX™) titanium electrodes. The distal slotted/blunt tip electrode is coated with polyethylene glycol. Fixation is achieved by silicone-rubber tines. The lead is compatible with pulse generators having VS•1*/IS-1** connectors.

III. INDICATIONS FOR USE

The ThinLine models 430-10 and 432-04 leads are intended for chronic pacing and sensing of the atrium or ventricle when used with a compatible pulse generator.

IV. CONTRAINDICATIONS

- Do not use this lead in patients with tricuspid valve disease.
- Do not use this lead in patients with mechanical tricuspid heart valves.

V. WARNINGS and PRECAUTIONS

See final product labeling (attached)

VI. ADVERSE EVENTS

The ThinLine clinical investigation, as of November 17, 1995, involved 730 devices (265 atrial/465 ventricular) implanted in 510 patients resulting in 5,929 cumulative implant months (mean implant duration was 8 months, range 0 to 23 months). There were 2 observations (both oversensing in atrial leads) and 36 complications reported during the study (see Table 1).

Twenty-one deaths were reported during the clinical investigation; none were judged to be lead-related.

Table 1. Adverse events for the ThinLine™ clinical trial
General phase, 510 patients, 730 leads, 5,929 device-months
Ventricular (Vent), 461 patients, 465 leads, 3,666 device-months
Atrial (Atr), 264 patients, 265 leads, 2,263 device-months

	# of patients			% of patients			# of leads*			Adverse events / lead-month		
OBSERVATIONS	Vent	Atr	Tot	Vent	Atr	Tot	Vent	Atr	Tot	Vent	Atr	Tot
Oversensing	0	2	2	0	0.76%	0.39%	0	2	2	0	0.00088	0.00034
COMPLICATIONS	Vent	Atr	Tot	Vent	Atr	Tot	Vent	Atr	Tot	Vent	Atr	Tot
Dislodgment - Repositioned	5	9	13	1.1%	3.4%	2.5%	5	9	14	0.0014	0.0040	0.0024
Dislodgment - Explanted	2	4	5	0.43%	1.5%	0.98%	2	4	6	0.00055	0.0018	0.0010
Lead Cut During Repositioning of Test or (Control) leads- Explanted	4	2	5	0.87%	0.76%	0.98%	1 3	1 1	2 4	0.00027 0.00082	0.00044 0.00044	0.00034 0.00068
Perforation	2	0	2	0.43%	0	0.39%	2	0	2	0.00055	0	0.00034
Phys. Elected Explants	2	0	2	0.43%	0	0.39%	2	0	2	0.00055	0	0.00034
P.G. Erosion - Explanted	1	1	1	0.22%	0.38%	0.20%	1	1	2	0.00027	0.00044	0.00034
Pocket Infection - Explanted	1	1	2	0.22%	0.38%	0.39%	1	1	2	0.00027	0.00044	0.00034
Pocket Hematoma - Explanted	1	0	1	0.22%	0	0.20%	1	0	1	0.00027	0	0.00017
Vent. Ectopy - Repositioned	1	0	1	0.22%	0	0.20%	1	0	1	0.00027	0	0.00017
Total (Any Complication)	19	17	32	4.1%	6.4%	6.3%	19	17	36	0.0052	0.0075	0.0061

Vent= Ventricular, Atr = Atrial, Tot=Total

Observations are defined as symptomatic or asymptomatic clinical events with potential adverse effects which do not require surgical intervention (can be corrected by reprogramming alone).

Complications are defined as symptomatic or asymptomatic clinical events with potential adverse effects which require surgical intervention. Explants are included as complications

The number of leads is also the number of Adverse Events (lead and non-lead related) as there were no patients who had the same event multiple times.

Potential Adverse Events Associated with Pacing Leads

Adverse events (including those reported in Table 1) associated with pacing leads based on historical implant experience include:

- cardiac perforation
- cardiac tamponade
- transvenous lead-related thrombosis
- elevated thresholds
- body rejection phenomena
- hematoma/seroma
- nerve and muscle stimulation
- myopotential sensing
- local tissue reaction
- fibrotic tissue formation
- oversensing
- dislodgment
- lead cut
- perforation
- physician elected explants
- pulse generator erosion
- pocket infection
- pocket hematoma
- ventricular ectopy

VII. ALTERNATIVE PRACTICES AND PROCEDURES

Other commercially available pacing leads may provide alternatives to ThinLine™ Model 430-10 and 432-04 endocardial pacing leads.

VIII. MARKETING HISTORY

Over 9500 ThinLine™ Model 430-10 and Model 432-04 leads were commercially distributed Internationally between February of 1992 and November of 1995. Countries of destination include:

Australia	Ireland
Austria	Israel
Belgium	Japan
Canada	Netherlands
Chile	Norway
Denmark	Portugal
Finland	Serbia
France	Spain
Germany	Sweden
Greece	Switzerland
India	Taiwan
Indonesia	Turkey

IX. SUMMARY OF NON-CLINICAL LABORATORY STUDIES

Non-clinical laboratory studies performed on the ThinLine™ Model 430-10 and 432-04 endocardial pacing leads include device related qualifications, biocompatibility evaluations and a chronic animal study.

1. DEVICE RELATED QUALIFICATIONS

Device related qualifications consisted of electrical and mechanical qualifications of the lead. The ThinLine™ Model 430-10 and 432-04 leads were subjected to the following device testing:

Dimensional Analysis
VS•1 and IS-1 Standards Testing
Environmental Testing
Electrical Testing
Mechanical Testing
Shelf Life Testing

a. DIMENSIONAL VERIFICATION

The ThinLine™ leads were tested to ensure that they met the engineering specifications following sterilization and packaging procedures. All leads successfully met the engineering specifications.

b. VS•1 AND IS-1 STANDARDS TESTING

The ThinLine™ lead connectors were evaluated to ensure that they complied with the requirements set forth in the VS•1 and IS-1 Standards.

Testing performed on 20 connector subassemblies (half-leads) included:

- dimensional analysis,
- IS-1 go-gauge and insertion force,
- set screw deformation, and
- impedance testing.

Testing performed on 40 full leads utilizing the identical connector assembly included:

- VS•1 insertion force,
- header extraction,
- isolation resistance,
- multiple insertions.

All leads and subassemblies successfully met the test requirements.

c. ENVIRONMENTAL TESTING

The ThinLine™ leads, Models 430-10 and 432-04, were subjected to environmental testing to ensure that the lead could withstand the normal stresses seen during shipping and handling. This testing included subjecting twenty (20) ThinLine™ leads to thermal shocks in excess of those required by the AAMI standard in addition to subjecting ten (10) ThinLine™ leads in their protective packaging to vibration profiles. All leads were subsequently examined for visual defects and tested electrically to ensure that the leads still met specifications. All leads successfully met the test requirements.

d. ELECTRICAL TESTING

Electrical verification was performed throughout the qualification testing of the Model 430-10 and 432-04 leads to ensure that the leads still functioned appropriately following the various test profiles induced. In addition, specific electrical testing was performed to evaluate the electrical function of the ThinLine™ leads.

i. Isolation Resistance Testing

Twenty (20) Model 430-10 and fifteen (15) Model 432-04 leads were immersed in lactated Ringer's solution at an elevated temperature for four weeks to ensure the integrity of the insulation materials, specifically the polyurethane, ETFE coating and glue joints. All leads maintained isolation resistance readings greater than the 50 kΩ requirement

ii. Connector Impedance Testing

This testing verified compliance to the IS-1 impedance requirements. A voltage in the 100-250 mV_{rms} range at a frequency ranging from 50 to 120 Hz was applied across the cathode conductor and saline solution. Twenty (20) connector subassemblies were inserted into IS-1 lead connector test cavities and soaked for ten days at body temperature. Following this, electrical impedance was measured to ensure that the impedance remained greater than 50 kΩ. Following analysis of the data and samples, it was determined that all subassemblies successfully met the requirements.

e. MECHANICAL TESTING

A series of tests were performed on the ThinLine™ leads to ensure that the leads exhibited mechanical integrity.

i. Lead Durability:

Twenty (20) ThinLine™ leads were tested to ensure that the lead design can withstand a one minute, non-destructive 1.1 pound load without damage to the leads. The leads were examined visually and electrically to ensure there was no damage as a result of the tensile loading. All leads successfully met the requirements of this testing.

ii. **Stylet Insertion and Retraction:**

Twenty-five Model 430-10 and fifteen Model 432-04 leads had stylets inserted and withdrawn from the lumen of the lead. This was performed with unfixtured leads, and with the leads under a one inch curvature radius. The removal force was verified to be less than 50 grams. Following the testing of the Model 432-04 (atrial "J" lead), the leads were reevaluated for conformance to the J-curvature requirements. All leads successfully met the requirements of this testing.

iii. **Introducer Testing**

Ten half-leads (distal portion) were subjected to introducer testing. All subassemblies were passed through and withdrawn from an eight French introducer five times with less than a one pound insertion force. All leads successfully met the test requirements, and no damage to the leads or tines were noted on any of the samples.

iv. **Fatigue Testing**

Fatigue testing was performed on full leads which had been subjected to the soak testing outlined previously, and on coated coil subassemblies. A fatigue evaluation was also performed to analyze the fatigue characteristics over a 10 year product life.

Lead Testing: Ten (10) ThinLine™ leads were flexed with a 0.5 lb. axial load for over one million cycles. Lead coil continuity was monitored during testing. All leads successfully completed the required testing with no anomalous behavior being exhibited.

Coil Subassemblies: Eight (8) coated coil subassemblies were fatigued using a cyclic axial elongation of 15%. All subassemblies withstood a minimum of 187 million cycles and successfully met the requirements of this testing.

v. Crimp Joint and Weld Testing

The following crimp joints and welds were pull tested to demonstrate acceptable performance:

Joints	# Tested
coil to cathode	20
coil to connector pin	30
coil to anode	20
coil to anode sleeve	30
crimp tube subassembly	60
coil to tip	30

All met or exceeded the minimum established design requirements for that particular joint (1.5 lb. with 99.9% confidence).

vi. Composite Pull Testing

The ThinLine™ leads were subjected to composite pull testing to destruction following the completion of the testing discussed above. All twenty (20) leads tested surpassed the minimum design requirement of 1.1 lb. with 95% confidence.

f. SHELF LIFE TESTING

Testing which demonstrates the functionality of the ThinLine™ leads following shelf storage was performed. This testing included repeating relevant tests listed above in addition to subjecting the packaged leads to humidity testing, thermal shock, drop testing and vibration. Ten (10) leads were examined following a shelf storage of two years. All leads successfully met the requirements of this testing.

2. BIOCOMPATIBILITY

GLP biocompatibility evaluations were conducted on ThinLine™ lead materials. These included the required short term and long term testing outlined in the FDA modified ISO-10993-1 matrix. Materials tested include:

Polyurethane 55D
Silicone Rubber
Iridium Oxide (IROX™)
Titanium
Polyethylene Glycol (PEG 3350)
ETFE
Polyimide
Polyester Film
Polyurethane and Silicone Medical Adhesives
Epoxy Resin

All materials tested successfully met the requirements of this testing.

3. BIOSTABILITY

The biostability of ETFE was evaluated in two leads explanted from two dogs after implant for greater than four years.

The biostability of polyimide tubing was evaluated in four leads explanted from four dogs after implant for greater than one year.

Comparative analysis between the implanted materials and control materials which had never undergone implant was performed for both the ETFE and Polyimide material. No discernible differences were noted.

4. CHRONIC ANIMAL STUDY

The Model 432-04 ThinLine™ lead underwent *in vivo* evaluation in animals to characterize the electrical behavior of the lead. This was accomplished by monitoring various electrical indicators every three months. Based on testing to 156 weeks, the leads conformed to specifications and demonstrated appropriate electrical behavior.

5. SUMMARY OF CLINICAL STUDIES

The ThinLine endocardial pacing lead models 432-04 and 430-10 were evaluated in a multi-center, two-phase study: an initial randomized control study (intensive phase) to evaluate the electrical performance of the leads to conventional bipolar, passive-fixation leads, and a general phase with one-year follow-up to establish

lead reliability (assess survival). The control leads for the initial intensive phase were models 430-07 (ventricular) and 432-03 (atrial). These leads are currently marketed standard, coaxial, passive-fixation leads. As of November 17, 1995, the clinical trial involved 730 devices (265 atrial and 465 ventricular) implanted in 510 patients resulting in 5,929 cumulative implant months (mean implant duration 8 months, range 0 to 23 months).

Primary Objectives:

- To establish lead reliability (survival) based on clinical data to 12 months and extrapolate to show better than 97% probability (with 95% confidence) of lead survival at 5 years.
- To compare ThinLine atrial and ventricular pacing leads to the control leads with regard to:
  - acute (< 3 months) and chronic lead electrical performance (i.e., capture and sensing thresholds, and lead impedance)
  - lead handling characteristics during implantation
- To assess adverse events (observations and complications).

Methods: Follow-up clinical and electrical measurements were taken at 2 weeks, 4 weeks, 6 weeks, 3 months, 6 months and 12 months during the intensive phase. The general phase of the study was non-randomized. The same follow-up schedule was followed with the exception of the 2-week and 6-week measurements. All patients enrolled in the intensive phase were also included in the general phase.

Results: Lead exponential survival is shown in Table 2, and includes data as of July 31, 1996. There were two failures in 14,235 device-months, resulting in a 99.8% 1-year survival with a lower confidence limit of 99.5%. Because of the low number of failures, the exponential model for survival probability was used. Survival extrapolated to 5 years was 99.2% with a lower confidence limit of 97.4% for atrial and ventricular leads combined.

Table 2. ThinLine survival probability, 14,235 device-months

Implant duration	95% lower confidence limit on survival probability
1 year (observed)	99.5%
5 years (extrapolated)	97.4%

Lead handling characteristics were judged excellent or good in 85% of implants for ThinLine leads compared to excellent or good in 83% of implants for control leads.

Table 3 shows the principal results for survival and adverse events.

Table 3. Patient description and principal safety results
General phase, 510 patients

Category	Ventricular Lead	Atrial Lead	All ThinLine
Patients	461	264	510
Devices*	465	265	730
Device Exposure, Months	3,666	2,263	5,929
Duration, mean Å SD (range), months	7.9 ± 5 8 (0–22.6)	8.5 ± 5.8 (0–21.7)	8.1 ± 5.8 (0–22.6)
Patient age per implant, mean ÅSD (range), years	70 ± 14 (17–100)	68 ± 16 (15–98)	69 ± 15 (15–100)
Sex, female, number, %	188, 41%	114, 43%	209, 41%
Cumulative Survival at 5 years	**	**	99.2%
Clinical Events, number, %	19, 4.1%	19, 7.2%	38, 5.2%

** Some patients implanted with more than one device.*

*** Cumulative survival based on total leads (not individually by atrial and ventricular), device experience as of July 31, 1996.*

Table 4 shows the electrical performance characteristics at 3 and 12 months.

Table 4. Electrical performance
intensive phase, 61 patients

		Ventricular			Atrial		
		ThinLine mean ± SD, # of patients	**Control** mean ± SD, # of patients	**Difference (95% Conf. Int)**	**ThinLine** mean ± SD, # of patients	**Control** mean ± SD, # of patients	**Difference (95% Conf. Int)**
Capture pulse width (ms) @ 1.5V	3 mos	0.20 ± 0.09 n=25	0.29 ± 0.17 n=26	-0.09 (-0.16, 0.01	0.25 ± 0.12 n=26	0.31 ± 0.32 n=22	-0.07 (-0.20, 0.07)
	12 mos	0.08 ± 0.09 n=20	0.27 ± 0.14 n=22	-0.19 (-0.27, -0.12)	0.19 ± 0.11 n=22	0.27 ± 0.30 n=15	-0.08 (-0.23,0.06)
Sensing threshold s (mv)	3 mos	7.3 ± 1.7 n=24	8.1 ± 2.0 n=24	-0.80 (-1.8, 0.34)	3.3 ± 1.5 n=28	3.2 ± 1.5 n=21	0.11 (-0.76, 0.98)
	12 mos	7.5 ± 2.2 n=22	8.1 ± 2.6 n=22	-0.65 (-2.1, 0.82)	3.4 ± 1.5 n=23	3.0 ± 1.4 n=20	0.39 (-0.49, 1.3)
Lead impedan ce (ohms)	3 mos	548 ± 109 n=25	647 ± 104 n=27	-99 (-158, -40)	479 ± 110 n=28	542 ± 62 n=24	-63 (-114, -12)
	12 mos	493 ± 111 n=21	622 ± 114 n=23	-129 (-198, -60)	489± 131 n=24	534 ± 59 n=20	-45 (-109, 19)

b. Patient Population and Gender Bias

There were 510 patients enrolled in the ThinLine™ investigation. Of these, 461 were implanted with a ventricular (Model 430-10) lead and 264 were implanted with an atrial (Model 432-04) lead (some patients were implanted with both ventricular and atrial leads). These leads were implanted at 43 centers , 39 in the US and fivein Canada. This patient population accounts for 5929 device months with 210 leads implanted for greater than twelve months. The average implant time is 8 months.

Of the patients enrolled in the ThinLine™ study, 41% were female. Females account for 50% of the patients receiving pacemakers 50% based on the Intermedics Patient Registration Database from 1990 to present. The lower proportion of females in this study was was accounted for by one center, a Veteran's Administration Hospital, with a nearly exclusively male population. Excluding that center resulted in a 47% female population.

X. DEVICE ACCOUNTABILITY, RELIABILITY & LONGEVITY

Table 5 provides a summary of all ThinLine™ leads used during the clinical investigation and their status as of November 17, 1995. Of the 465 ventricular and 265 atrial leads in the study, 430 ventricular and 243 atrial leads are still active. There have been twenty one (21) patients with 17 ventricular and 12 atrial ThinLine™ leads who have died during the clinical trial. None of the deaths were related to the ThinLine™ leads. Of the deaths, thirteen were cardiac related and 8 were not cardiac related. Additionally, there are 5 patients (5 ventricular leads, 2 atrial) leads) which are lost to follow-up.

Seventeen ThinLine™ leads were explanted during the clinical study (10 ventricular and 7 atrial). Only one patient who died had the ThinLine™ lead explanted. Of the explanted leads, all either tested within specifications, or could not be analyzed because they were damaged during the explant procedure with the exception of one lead. One lead was explanted due to high thresholds and low impedance testing. Upon analysis, a short was located between the crimp sleeve and cathode wire at the connector. A change was made to the manufacturing process of the lead connector section to minimize the possibility of this occurrence.

Table 5. ThinLine™ lead Accountability;
Total devices implanted Atrial (n=265), Ventricular (n=465)

	Ventricular Model 430-10	***Atrial Model 432-04***
Devices Implanted		
Total Device (Patients)	465 (461)*	265 (264)**
Still Active	430	243
Death	17	12
Lost to Follow Up	5	2
Explanted	9	7
Out-of-Service Devices		
Due to Death		
Not Returned	16	12
Returned	1	0
Due to Explantation (returned)		
Lead Cut During Repositioning	4 (2)	2 (1)
Lead dislodged, repositioning unsuccessful	0	3 (1)
Pocket Infection / Erosion of Pulse Generator	2	2 (1)
Pulse Generator damaged due to cardioversion shock; ICD implantedwith ventricular active fixation lead	1 (1)	0
High Thresholds / Low Impedance	1 (1)	0
Patient had no trabeculae	1 (1)	0
Returned Devices		
Analysis Results	(6)	(3)
Tested within Engineering Specs	4	2
Short located between the crimp sleeveand the cathode wire in the connector / holes on the ETFE due to manufacturing process	1	0
Analysis not possible (lead cut into multiple pieces during explant)	1	1

** 3 Ventricular patients had replacement ventricular ThinLine™ Model 430-10 leads upon explant of original lead. One patient included in the patient count had only a control lead. All data included in data analysis.*

***One atrial patient had a replacement ThinLine™ Model 432-04 lead upon explant of his original lead. All data included in data analysis.*

XI. CONCLUSIONS DRAWN FROM STUDIES

The results of the *in vitro* testing in conjunction with the performance of the leads observed in the clinical evaluation provide reasonable assurance that the ThinLine™ Models 430-10 and 432-04 endocardial pacing leads are safe and effective when used as indicated in the product labeling.

XII. PANEL RECOMMENDATION

Pursuant to section 515(f)(2) of the act as amended by the Safe Medical Devices Act of 1990, this PMA was not referred to the Circulatory System Devices Panel, as an FDA advisory panel, for review and recommendation because the information in the PMA substantially duplicated information previously reviewed by this panel.

XIII. CDRH DECISION

FDA issued an approval order on November 12, 1996. The applicant's manufacturing facility was inspected and was found to be in compliance with the device Good Manufacturing Practice regulations.

XIV. APPROVAL SPECIFICATION

Directions for use: See the labeling.

Hazards to Health from Use of the Device: See Indications, Contraindications, Warnings, precautions and Adverse Events in the labeling.

Postapproval Requirements and Restrictions: See approval order.

Continued approval of the device is contingent upon the submission of post-approval reports to the Food and Drug Administration as described in the "Conditions of Approval" enclosed in the approval letter.

Final, 10/96

ThinLine™

Models 430-10 and 432-04

Intermedics®
Implantable Pacing Leads

CAUTION: Federal (U.S.A.) Law restricts this device to sale by or on the order of a physician.

DESCRIPTION

The ThinLine™ models 430-10 and 432-04 atrial and ventricular bipolar, passive-fixation, endocardial pacing leads are intended for permanent atrial and ventricular placement. Each lead is composed of two individually ETFE-coated conductor wires co-radially wound together to form a single conductor coil. The leads include polyurethane outer insulation and iridium oxide-coated (IROX™) titanium electrodes. The distal slotted/blunt tip electrode is coated with polyethylene glycol. Fixation is achieved by silicone-rubber tines. The lead is compatible with pulse generators having VS•1*/IS-1** connectors.

Symbols Used

Attention! Consult the accompanying documentation.

INDICATIONS

The ThinLine models 430-10 and 432-04 leads are intended for chronic pacing and sensing of the atrium or ventricle when used with a compatible pulse generator.

CONTRAINDICATIONS

- Do not use this lead in patients with tricuspid valve disease.
- Do not use this lead in patients with mechanical tricuspid heart valves.

WARNINGS

- The use of battery-powered equipment is recommended during lead implantation and testing to protect against fibrillation that may be caused by alternating currents.
- Line-powered equipment used in the vicinity of the patient must be properly grounded.
- Lead connector pins must be insulated from any leakage currents that may arise from line-powered equipment.

PRECAUTIONS

General

- The ThinLine lead and its accessories are intended for one-time use only. Do not reuse.
- Inspect sterile packaging prior to opening. Do not use if damaged (see p.5).
- Prior to the implantation of this lead, confirm lead/pulse generator compatibility by contacting Intermedics customer service.
- Defibrillating equipment should be kept nearby for immediate use during the implantation procedure.

Handling

- Do not damage the polyurethane insulation of the lead as this might allow body fluids to seep into the lead and could prevent proper lead function.
- Do not wipe or immerse the electrode in fluid.

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* VS•1 is an intra-industry agreement that standardizes lead-to-pulse generator connection dimensions.
** International Standard ISO 5841-3: 1992.

- To prevent damage to the lead or potential lead dislodgment, do not use excessive force or surgical instruments in handling. Use a suture sleeve to avoid placing the lead under extreme tension.
- Avoid bending the coil conductor, since attempts to restore the original shape may weaken the structure.

Implanting

- Use a lateral venipuncture when using a subclavian introducer to avoid a venous entry point that would allow the body of the pacing lead to be clamped (crushed) between the clavicle and first rib producing "subclavian crush".
- Remove the stylet and funnel/cap before connecting the lead to the pulse generator. Leaving the stylet in the lead could cause coil fracture and/or heart perforation.
- Do not suture directly to the polyurethane insulation. Always use the suture sleeve to anchor the lead.

ADVERSE EVENTS

The ThinLine clinical investigation, as of November 17, 1995, involved 730 devices (265 atrial/465 ventricular) implanted in 510 patients resulting in 5,929 cumulative implant months (mean implant duration was 8 months, range 0 to 23 months). There were 2 observations and 36 complications reported during the study (see Table 1).

Twenty-one deaths were reported during the clinical investigation; none were judged to be lead-related.

Potential Adverse Events

Adverse events which may occur based on historical implant experience include:

- cardiac perforation
- cardiac tamponade
- transvenous lead-related thrombosis
- elevated thresholds
- body rejection phenomena
- hematoma/seroma
- nerve and muscle stimulation
- myopotential sensing
- local tissue reaction
- fibrotic tissue formation
- oversensing
- dislodgment
- lead cut
- perforation
- physician elected explants
- pulse generator erosion
- pocket infection
- pocket hematoma
- ventricular ectopy

CLINICAL SUMMARY

The ThinLine endocardial pacing lead models 432-04 and 430-10 were evaluated in a multi-center, two-phase study: an initial randomized control study (intensive phase) to evaluate the electrical performance of the leads to conventional bipolar, passive-fixation leads, and a general phase with one-year follow-up to establish lead reliability (assess survival). The control leads for the initial intensive phase were models 430-07 (ventricular) and 432-03 (atrial). These leads are currently marketed standard, coaxial, passive-fixation leads. As of November 17, 1995, the clinical trial involved 730 devices (265 atrial and 465 ventricular) implanted in 510 patients resulting in 5,929 cumulative implant months (mean implant duration 8 months, range 0 to 23 months).

Primary Objectives:

- To establish lead reliability (survival) based on clinical data to 12 months and extrapolate to show better than 97% probability (with 95% confidence) of lead survival at 5 years.
- To compare ThinLine atrial and ventricular pacing leads to the control leads with regard to:
  - acute (< 3 months) and chronic lead electrical performance (i.e., capture and sensing thresholds, and lead impedance)
  - lead handling characteristics during implantation
- To assess adverse events (observations and complications).

Table 1. Adverse events for the ThinLine clinical trial,
general phase, 510 patients, 730 leads, 5,929 device-months
Ventricular (Vent), 461 patients, 465 leads, 3,666 device-months
Atrial (Atr), 264 patients, 265 leads, 2,263 device-months

	# of patients			% of patients			# of leads*			Adverse events/ lead-month		
OBSERVATIONS	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**
Oversensing	0	2	2	0	0.76%	0.39%	0	2	2	0	0.00088	0.00034
COMPLICATIONS	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**	**Vent**	**Atr**	**Tot**
Dislodgment - Repositioned	5	9	13	1.1%	3.4%	2.5%	5	9	14	0.0014	0.0040	0.0024
Dislodgment - Explanted	2	4	5	0.43%	1.5%	0.98%	2	4	6	0.00055	0.0018	0.0010
Lead Cut During Repositioning of Test or (Control) leads - Explanted	4	2	5	0.87%	0.76%	0.98%	1 3	1 1	2 4	0.00027 0.00082	0.00044 0.00044	0.00034 0.00068
Perforation	2	0	2	0.43%	0	0.39%	2	0	2	0.00055	0	0.00034
Phys. Elected Explants	2	0	2	0.43%	0	0.39%	2	0	2	0.00055	0	0.00034
P.G. Erosion - Explanted	1	1	1	0.22%	0.38%	0.20%	1	1	2	0.00027	0.00044	0.00034
Pocket Infection - Explanted	1	1	2	0.22%	0.38%	0.39%	1	1	2	0.00027	0.00044	0.00034
Pocket Hematoma - Explanted	1	0	1	0.22%	0	0.20%	1	0	1	0.00027	0	0.00017
Vent. Ectopy - Repositioned	1	0	1	0.22%	0	0.20%	1	0	1	0.00027	0	0.00017
Total (any complication	19	17	32	4.1%	6.4%	6.3%	19	17	36	0.0052	0.0075	0.0061

Vent=Ventricular, Atr=Atrial, Tot=Total

Observations are defined as symptomatic or asymptomatic clinical events with potential adverse effects which do not require surgical intervention (can be corrected by reprogramming alone).

Complications are defined as symptomatic or asymptomatic clinical events with potential adverse effects which require surgical intervention. Explants are included as complications.

* The Number of leads is also the number of Adverse Events (lead and non-lead related) as there were no patients who had the same event multiple times

Methods: Follow-up clinical and electrical measurements were taken at 2 weeks, 4 weeks, 6 weeks, 3 months, 6 months and 12 months during the intensive phase. The general phase of the study was non-randomized. The same follow-up schedule was followed with the exception of the 2-week and 6-week measurements. All patients enrolled in the intensive phase were also included in the general phase.

Results: Lead exponential survival is shown in Table 2, and includes data as of July 31, 1996. There were two failures in 14,235 device-months. Because of the low number of failures, the exponential model for survival probability was used, which is a function of implant duration and mean time to failure. Exponential survival extrapolated to 5 years was 99.2% for ventricular and atrial leads combined.

Table 2. ThinLine survival probability, 14,235 device-months

Implant duration years	Survival probability	95% lower confidence limit on survival probability
1	99.83%	99.47%
2	99.66%	98.94%
3	99.50%	98.42%
4	99.33%	97.90%
5	99.16%	97.38%

Lead handling characteristics were judged excellent or good in 85% of implants for ThinLine leads compared to excellent or good in 83% of implants for control leads.

Table 3 shows the principal results for survival and adverse events.

Table 3. Patient description and principal safety results, general phase, 510 patients

Category	*Ventricular Lead*	*Atrial Lead*	*All ThinLine*
Patients	461	264	510
Devices*	465	265	730
Device exposure, months	3,666	2,263	5,929
Duration, mean ± SD	7.9 ± 5.8	8.5 ± 5.8	8.1 ± 5.8
(range), months	(0–22.6)	(0–21.7)	(0–22.6)
Patient age per implant, mean ±SD	70 ± 14	68 ± 16	69 ± 15
(range), years	(17–100)	(15–98)	(15–100)
Sex, female, number, %	188, 41%	114, 43%	209, 41%
Cumulative survival at 5 years	-	**	99.2%
Clinical events, number, %	19, 4.1%	19, 7.2%	38, 5.2%

* *Some patients implanted with more than one device.*
** *Cumulative survival based on total leads (not individually by atrial and ventricular), device experience as of July 31, 1996.*

Table 4 shows the electrical performance characteristics at 3 and 12 months.

The complications and observations reported for all ThinLine patients are reported in Table 1 (see p.3).

Table 4. Electrical performance, intensive phase, 61 patients

		Ventricular			Atrial		
		ThinLine mean ± SD, # of patients	Control mean ± SD, # of patients	Difference (95% Conf. Int.)	ThinLine mean ± SD, # of patients	Control mean ± SD, # of patients	Difference (95% Conf. Int.)
Capture pulse width (ms) @ 1.5V	3 months	0.20 ± 0.09 n=25	0.29 ± 0.17 n=26	-0.09 (-0.16, 0.01)	0.25 ± 0.12 n=26	0.31 ± 0.32 n=22	-0.07 (-0.20, 0.07)
	12 months	0.08 ± 0.09 n=20	0.27 ± 0.14 n=22	-0.19 (-0.27, -0.12)	0.19 ± 0.11 n=22	0.27 ± 0.30 n=15	-0.08 (-0.23, 0.06)
Sensing thresholds (mv)	3 months	7.3 ± 1.7 n=24	8.1 ± 2.0 n=24	-0.80 (-1.8, 0.34)	3.3 ± 1.5 n=28	3.2 ± 1.5 n=21	0.11 (-0.76, 0.98)
	12 months	7.5 ± 2.2 n=22	8.1 ± 2.6 n=22	-0.65 (-2.1, 0.82)	3.4 ± 1.5 n=23	3.0 ± 1.4 n=20	0.39 (-0.49, 1.3)
Lead impedance (ohms)	3 months	548 ± 109 n=25	647 ± 104 n=27	-99 (-158, -40)	479 ± 110 n=28	542 ± 62 n=24	-63 (-114, -12)
	12 months	493 ± 111 n=21	622 ± 114 n=23	-129 (-198, -60)	489 ± 131 n=24	534 ± 59 n=20	-45 (-109, 19)

IMPLANTATION INFORMATION

Sterilization

This product is supplied in a sterile package for direct introduction into the operating field. The package and its contents have been exposed to ethylene oxide gas, and sterility is verified on each lot. Before the package is opened, it should be examined carefully for damage that may have compromised sterility. (For instructions on opening the sterile package, see Figures 1 and 2.) If such damage is detected, the entire contents may be repackaged in a gas-permeable container and resterilized once using a validated ethylene oxide gas process. Follow the manufacturer's operating instructions for the particular sterilization equipment used, as long as the temperature does not exceed 55°C (131°F). **Do not autoclave this lead.**

Following resterilization, the lead and its accessories should be stored at 43°C (110°F) for a minimum of 24 hours (or equivalent conditions) to permit aeration of ethylene oxide gas residuals prior to implantation.

Do not resterilize this device more than one time.

Storage

The lead should be stored at temperatures between -5°C (23°F) and 55°C (131°F).

Handling

While the lead is durable and flexible and easily tolerates normal handling, the conductor or its insulating material may be damaged if stretched, crimped or crushed. Avoid subjecting the lead to these or other unusual stresses.

The lead's polyurethane insulating material has an electrostatic affinity for particulate matter and thus should not be exposed to lint, dust or other similar contaminants.

Precautions

- Do not damage the polyurethane insulation of the lead as this might allow body fluids to seep into the lead and could prevent proper lead function.
- Do not wipe or immerse the electrode in fluid.
- To prevent damage to the lead or potential lead dislodgment, do not use excessive force or surgical instruments in handling. Use a suture sleeve to avoid placing the lead under extreme tension.
- Avoid bending the coil conductor, since attempts to restore the original shape may weaken the structure.

General Information

It is important to position the lead so as to minimize mechanical stresses and maximize electrical contact with the cardiac wall. Implantation should, therefore, be performed in a facility permitting fluoroscopic verification of satisfactory lead tip placement.

Available transvenous implantation routes include the cephalic, subclavian and external or internal jugular veins. Venous access can be gained by employing either the cutdown or venipuncture technique.

If the subclavian route is selected and access by venipuncture is preferred, a percutaneous lead introducer (8 French or larger) should be used, and its application should be guided by the following consideration.

Precautions

- Use a lateral venipuncture when using a subclavian introducer to avoid a venous entry point that would allow the body of the pacing lead to be clamped (crushed) between the clavicle and first rib producing "subclavian crush".
- Remove the stylet and funnel/cap before connecting the lead to the pulse generator. Leaving the stylet in the lead could cause coil fracture and/or heart perforation.
- Do not suture directly to the polyurethane insulation. Always use the suture sleeve to anchor the lead.

Insertion Procedures

To employ the cutdown technique, expose and incise the desired vein. For the venipuncture technique, insert a lead-introducer sheath into the desired vein (see instruction sheet packaged with introducer). Under fluoroscopic observation and with a straight stylet fully inserted into the lead, either introduce the lead into the incised vein (for cutdown), or advance the lead through the lead-introducer sheath and into the desired vein (for venipuncture—see Figure 3). If desired, the vein lifter included in the sterile package may be used to facilitate lead introduction (see Figure 4) when employing the cutdown technique.

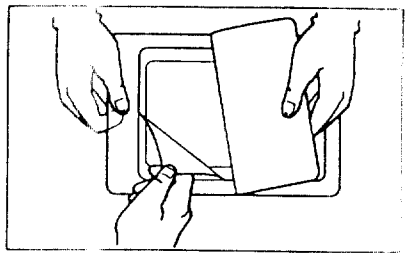
Cautiously advance the lead. If resistance is encountered, withdraw the lead a short distance and then readvance it. Repeat this procedure until the lead tip enters the right atrium. The tip of an atrial or ventricular lead can be advanced to the desired stimulation site by following one of the two procedures below.

Atrial Placement

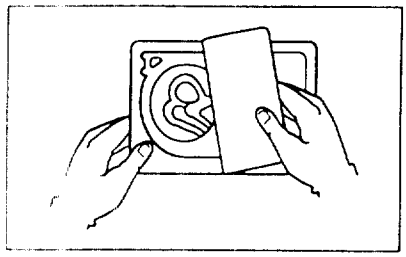
1. After advancing the lead tip into the right atrium, partially withdraw the stylet so that the lead's distal end begins resuming its J shape and points anteromedially.
2. Maintaining fluoroscopic observation, advance the lead tip while holding the stylet stationary until the tip enters and becomes lodged in the atrial appendage.
3. If the lead tip is properly lodged in the appendage, the lead's J curve will straighten slightly when the lead is *gently* retracted a short distance. Under AP fluoroscopy, the lead tip should point medially toward the left atrium and should sway from side to side with each atrial contraction.

Ventricular Placement

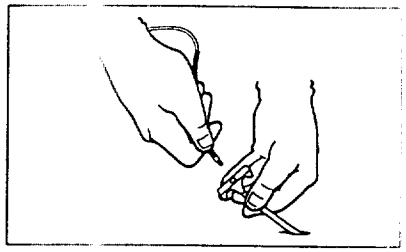
1. After advancing the lead tip into the right atrium, replace the straight stylet with one that has been slightly curved at the distal end. (Curve the stylet as shown in Figure 5.) The curve will assist in passing the lead across the tricuspid valve into the ventricle.
2. Once the lead has entered the ventricle, the straight stylet should be used again to cautiously advance the lead until the tip is lodged in the trabeculae at the apex. Be careful not to perforate the ventricular wall.
3. Verify with lateral fluoroscopy that the lead tip is not in a posterior position, which would probably indicate that it has entered the coronary sinus and must be repositioned.



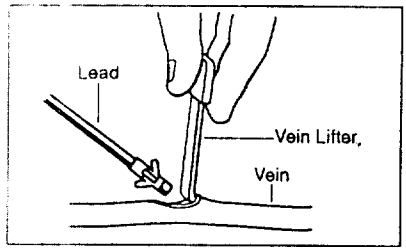
1. Peel back the cover from the outer tray. Using the folded corner flap, remove the sterile inner tray.



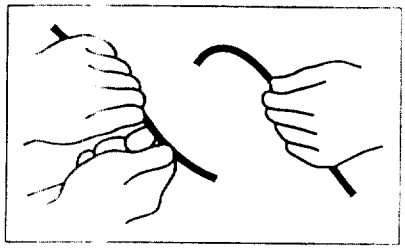
2. Peel the lid from the inner tray to present the lead and accessories.



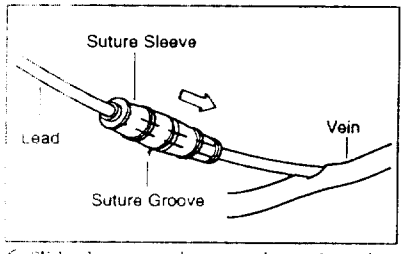
3. Advance the lead through the sheath of a percutaneous introducer and into the vein



4. The vein lifter may be used to lift and dilate the incised vein for introducing the lead.



5. Impart a gentle curve to the stylet by drawing it through a gloved hand or across a smooth, sterile instrument.



6. Slide the integral suture sleeve into the desired anchor position, and secure with a nonabsorbable suture.

Figures 1-6

Threshold Measurements

A pacemaker system analyzer is recommended for measuring the stimulation threshold and the appropriate sensing signal amplitude. During this procedure, the stylet should be withdrawn.

The lowest possible pacing threshold should be sought to assure optimal long-term pacemaker operation. Usually, using a 500Ω load, an acute ventricular stimulation threshold can be obtained below 0.6 V or 1.2 mA; however, maintaining the same resistance it should not exceed 1.0 V or 2.0 mA.

Acute stimulation thresholds in the right atrial appendage are generally higher than those obtained in the right ventricle with a stimulating electrode of similar surface area. Acute atrial stimulation thresholds below 1.0 V or 2.0 mA with a 500Ω load are common. But any acute atrial threshold substantially higher than 1.5 V or 3.0 mA (using a 500Ω load) indicates a need to reposition the lead.

For satisfactory sensing, the ventricular sensing signal amplitude should be at least 5.0 mV. The atrial sensing signal amplitude will typically range from 0.5 to 4.0 mV, but a value of 1.5 mV or above is preferable.

CAUTION: Be sure that the stylet has been removed before connecting the lead to the implanted pulse generator. Leaving the stylet in the lead could cause coil fracture and/or heart perforation. Also be sure that any funnel/cap installed over the lead connector(s) [as a guide for the stylet and to maintain lubrication of the connector] has been removed.

Securing the Lead

Once electrode stability and a satisfactory stimulation threshold have been attained, slide the pre-installed suture sleeve into position at the desired anchor point. Secure the sleeve to the lead by tying a non-absorbable suture around the sleeve near its middle (see Figure 6). Pass an end of the same suture through subcutaneous tissue and once again tie it around the sleeve.

NOTE: The suture should be tied tight enough to prevent the lead from moving within the sleeve, but not so tight that it might deform the lead's conductor coil.

Specifications

	430-10 (ventricular)	432-04 (atrial)
Polarity	Bipolar	Bipolar
Distal Assembly		
Introducer size (minimum)	8 French (2.7 mm)	8 French (2.7 mm)
Tine material	Silicone rubber	Silicone rubber
Electrode(s)		
Tip (cathode)		
Shape	Slotted/blunt	Slotted/blunt
Diameter	2.2 mm (6.5 French)	2.2 mm (6.5 French)
Surface area	8 mm^2	8 mm^2
Materials	IROX (Iridium oxide-coated titanium)	IROX (Iridium oxide-coated titanium)
Coating (soluble)*	Polyethylene glycol	Polyethylene glycol
Sleeve (anode)		
Surface area	37 mm^2	37 mm^2
Materials	IROX (Iridium oxide-coated titanium)	IROX (Iridium oxide-coated titanium)
Separation between electrodes	30 mm	13 mm
Lead Body		
Conductor construction	Parallel-wound bifilar coil	Parallel-wound bifilar coil
Conductor material	Nickel-cobalt alloy with silver core	Nickel-cobalt alloy with silver core
Conductor wire insulation	Polymer material	Polymer material
Insulation	55D Polyurethane	55D Polyurethane
Length**	58 cm	52 cm
Diameter	1.7 mm (5 French)	1.7 mm (5 French)
Resistance		
To tip	40 Ω maximum	40 Ω maximum
To sleeve	40 Ω maximum	40 Ω maximum
J-curve radius	—	1.5 cm
Connector Assembly		
Diameter	3.2 mm (VS•1/IS-1†)	3.2 mm (VS•1/IS-1)
Materials	Silicone rubber, 316L stainless steel	Silicone rubber, 316L stainless steel
Connector pin diameters		
Cathode	1.6 mm	1.6 mm
Anode	2.7 mm	2.7 mm
Connector pin length	5 mm	5 mm
Accessories included	Stylets (4)	Stylets (4)
	Funnel (1)	Funnel (1)
	Vein lifter (1)	Vein lifter (1)

* The tip electrode is lightly coated with less than 2 mg of polyethylene glycol (PEG), which is intended to maintain the cleanliness of the electrode during the packaging process. The PEG dissolves rapidly on contact with blood.

** Additional lengths available upon request

† VS•1 is an intra-industry agreement that standardizes lead-to-pulse generator connection dimensions

† International Standard ISO 5841-3: 1992

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